



## Exteriorized colon anastomosis for unprepared bowel: An alternative to routine colostomy

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Received: 2007-02-17 Accepted: 2007-03-21

be an alternative to routine colostomy. It is suitable where colostomy is socially unacceptable or the facilities and care is not available.

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**Key words:** Colostomy; Exteriorized colon; Colon injury; Colon anastomosis; Unprepared colon; Obstructing colon cancer; Volvulus sigmoid

Asfar SK, Al-Sayer HM, Juma TH. Exteriorized colon anastomosis for unprepared bowel: An alternative to routine colostomy. *World J Gastroenterol* 2007; 13(23): 3215-3220

<http://www.wjgnet.com/1007-9327/13/3215.asp>

### Abstract

**AIM:** To see the possibility of avoiding routine colostomy in patients presenting with unprepared bowel.

**METHODS:** The cohort is composed of 103 patients, of these, 86 patients presented as emergencies (self-inflicted and iatrogenic colon injuries, stab wounds and blast injury of the colon, volvulus sigmoid, obstructing left colon cancer, and strangulated ventral hernia). Another 17 patients were managed electively for other colon pathologies. During laparotomy, the involved segment was resected and the two ends of the colon were brought out *via* a separate colostomy wound. One layer of interrupted 3/0 silk was used for colon anastomosis. The exteriorized segment was immediately covered with a colostomy bag. Between the 5<sup>th</sup> and 7<sup>th</sup> postoperative day, the colon was easily dropped into the peritoneal cavity. The defect in the abdominal wall was closed with interrupted nonabsorbable suture. The skin was left open for secondary closure.

**RESULTS:** The mean hospital stay ( $\pm$  SD) was  $11.5 \pm 2.6$  d (8-20 d). The exteriorized colon was successfully dropped back into the peritoneal cavity in all patients except two. One developed a leak from oesophago-jejuno-stomy and from the exteriorized colon. She subsequently died of sepsis and multiple organ failure (MOF). In a second patient the colon proximal to the exteriorized anastomosis prolapsed and developed severe serositis, an elective ileo-colic anastomosis (to the left colon) was successfully performed.

**CONCLUSION:** Exteriorized colon anastomosis is simple, avoids the inconvenience of colostomy and can

### INTRODUCTION

Colostomy was introduced in surgical practice more than 200 years ago as a simple and safe procedure<sup>[1]</sup>. Since then, the time honored dictums "exteriorize colon injuries" and a "well prepared bowel is a pre-requisite for any colon repair", formed the basis for sound colon surgery. In 1945, the practice of routine colostomy was challenged by a military surgeon, James Mason, who introduced the technique of primary suture of unprepared colon and exteriorizing the segment of bowel outside the peritoneal cavity<sup>[2]</sup>. Initially, this technique did not gain much momentum in civilian practice mainly because of difficulties encountered in introducing procedures which would challenge established orthodox surgical practice. Nevertheless few reports appeared in the literature since the 1970s using Mason's technique in the emergency management of colon injuries. A literature review of 339 patients treated for colonic injuries by primary repair and exteriorization showed that colostomy was avoided in 63.3% of these patients<sup>[3]</sup>. These patients were saved the staged procedure for colostomy closure and repeated hospital admission.

In many cultures colostomy is not socially acceptable and is strongly resented by patients. In the third world and most developing countries, colostomy appliances are unaffordable or not heard of, special toilet facilities are non-existent and expert personnel in colostomy care are not available. In such circumstances, procedures which would spare patients the inconvenience of colostomy would be most valuable. Nearly all previous studies implementing primary repair and exteriorization of the

colon were for colon injuries. In this report we present data on the successful outcome of using this procedure in the management of other colonic pathologies.

## MATERIALS AND METHODS

This report is on prospectively collected data and follow up of a cohort of patients treated by a team of senior surgeons who preferentially used this technique (whenever feasible) over routine colostomy. Primary colonic anastomosis is not practiced by the authors of this report; they reverted to this technique instead.

In this cohort, there were 103 patients (20 females and 83 males). The primary diagnosis and demographics are shown in Table 1. The self-inflicted colon injuries were due to the introduction of long stiff objects in the rectum by male patients for sexual satisfaction. All these injuries were above the peritoneal reflection causing faecal peritonitis. Most patients in this cohort were admitted to hospital because of an emergency colonic pathology. Others, extension of stomach cancer, iatrogenic colon injuries and endometriosis were peroperative findings which necessitated colon surgery.

In the trauma group, 15 patients had associated injuries in addition to the colon (Table 2). Two patients had minor tears of the liver which were not actively bleeding and were not disturbed. The colon Organ Injury Scale as described by Moore *et al*<sup>[4]</sup> was used to grade the colon injuries (Table 3).

Gastric cancer patients whom at laparotomy were found to have extension to the transverse colon were managed by total gastrectomy and oesophago-jejunostomy. The affected colon was resected, anastomosed and exteriorized.

Emergency admissions were resuscitated with I.V. fluids, blood transfusions and urgent management of any concomitant injuries (e.g. pneumothorax), the patients were taken to the operating room for emergency laparotomy. Broad spectrum i.v. antibiotics (metronidazole and third generation cephalosporin) were given with induction of anaesthesia and continued for 48 h postoperatively. *Via* a midline laparotomy incision, the peritoneal cavity was inspected, the extent of damage was assessed and any associated injuries noted. Active bleeding points were immediately controlled and faecal soiling from the colon were temporarily controlled with intestinal clamps. The peritoneal cavity was washed with 3 liters of antibiotic solution. Associated small bowel injuries were repaired or resected and anastomosed. Thereafter, the colon proximal and distal to the site of pathology was fully mobilized to ensure a very redundant loose colon. Whenever possible, the colon segment bearing the pathology was brought out *via* a colostomy wound (usually on the left side) so that the subsequent colon resection and anastomosis can be carried out extraperitoneally. If this was not possible e.g. dilated or severely injured colon or in cases of colon cancer, the segment of colon was resected and both ends kept closed by clamps or staples of the mechanical G.I. stapler. Obstructing left colon carcinoma were radically excised with proximal and distal clear margins, ligation of mesenteric vessels and in-continuity excision of the mesentery and its lymphatics.

Table 1 Diagnosis and demographic data of all the patients

Diagnosis	n	Male	Female	Age (yr) mean $\pm$ SD
1 Self-inflicted colon injury	22	22	0	23.6 $\pm$ 9.4
2 <sup>3</sup> Trauma (stab wounds and blast trauma)	16	15	1	31 $\pm$ 8.6
3 Volvulus sigmoid colon	20	16	4	56.7 $\pm$ 7.0
4 <sup>1</sup> Stomach cancer extending to transverse colon	9	7	2	53 $\pm$ 9.6
5 <sup>1</sup> Obstructing left colon cancer	14	11	3	54.7 $\pm$ 11
6 Amoebic colon abscess	4	3	1	40.7 $\pm$ 9.6
7 Endometriosis of left colon	4	0	4	31.2 $\pm$ 3.5
8 Ischaemic colitis (post-AAA repair)	4	4	0	57.2 $\pm$ 3.3
9 <sup>2</sup> Iatrogenic	6	5	1	31.6 $\pm$ 7.7
10 Strangulated ventral hernia	4	0	4	54 $\pm$ 2.0
Total	103	83	20	42.4 $\pm$ 16.3

<sup>1</sup>Comorbid conditions in 40% of patients in each group e.g. diabetes mellitus, schaeic heart disease, hypertension and chronic obstructive airway disease.

<sup>2</sup>Involved hepatic flexure, 3 splenic flexure. <sup>3</sup>3 patients involved in blast trauma.

Table 2 Associated injuries in patients presenting with stab wounds

	n
Small bowel injury	5
Stomach injury	2
Mesenteric tear	4
Pneumothorax	2
Liver tear (minor)	2
Total	15

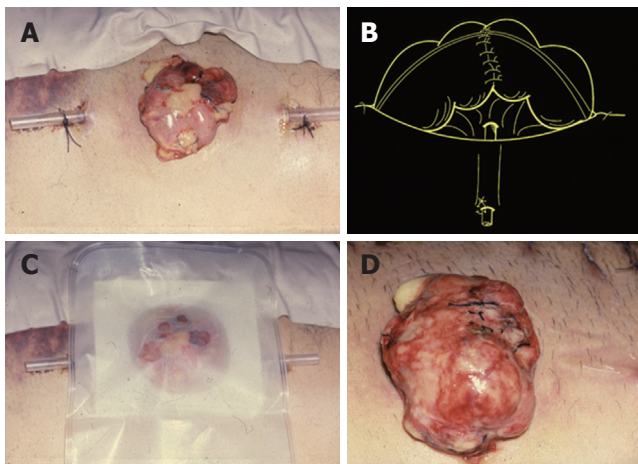
Table 3 Colon Organ Injury Scale<sup>1</sup> (Moore *et al*, 1990)

Grade	Injury
I	Haematoma Contusion or haematoma without devascularization
	Laceration Partial thickness, no perforation
II	Laceration < 50% of the circumference
III	Laceration $\geq$ 50% of the circumference without transection
IV	Laceration Transection of the colon
V	Laceration Transection of the colon with segmental tissue loss
	Vascular Devascularised segment

<sup>1</sup>Advance one grade for multiple injuries of the same organ.

Following colonic mobilization, the resected colon ends (or the colon segment bearing the pathology) were brought out *via* a colostomy wound which was usually made in the left iliac fossa. The operator should make sure that both ends of the colon are fully mobilised, viable and can easily come out *via* the colostomy wound with no undue tension. This is the most important step in the procedure. A second peritoneal wash with 3 liters of antibiotic solution was carried out and the peritoneal cavity and bowel checked for any bleeding or missed injury. The laparotomy wound was then closed *en masse* with no peritoneal drains and the wound covered with sterile dressing.

The exteriorized colon ends were anastomosed (one layer of interrupted 3/0 silk). To keep the colon exteriorized, a sturdy drain tube or a piece of chest tube was passed *via* the mesenteric border, then each end passed



**Figure 1** A: The colon immediately after primary anastomosis and exteriorization. This was a blast trauma victim (see ecchymosis of abdominal wall). Note the placement of the drain tube holding the colon, there is enough skin all around to allow for the colostomy bag fixation; B: Schematic representation of the exteriorization technique. Note the exit sites of the sturdy drain tube holding the colon in position. There is enough skin around the colon to allow immediate application of the colostomy bag in theatre; C: The immediate covering of the colon with a colostomy bag in the operating room (same patient as in A); D: The exteriorized colon at d 5, immediately before “drop-back” into the peritoneal cavity. Early serositis and oedema is apparent as compared to the same loop immediately after surgery (A). Delaying “drop-back” beyond this time would worsen the serositis and lead to break down of the suture line or leak after interiorization.

subcutaneously and brought out *via* small incisions 3-4 cm away from the colostomy incision (Figure 1A and B). This technique leaves enough skin around the colostomy incision for immediate and snug application of the colostomy appliance and bag in the operating room (Figure 1C). This method keeps the exteriorized colon moist and reduces the chances of serositis and contamination (Figure 1C)<sup>[5]</sup>.

Postoperatively, the colostomy bag was kept on the exteriorized colon until it is interiorized (dropped back) into the peritoneal cavity. The colon is inspected twice daily for any visible or invisible leaks (faecal odor), for viability and oedema. Between the 5<sup>th</sup>-7<sup>th</sup> postoperative day, if the colon is healthy with no demonstrable leak, the patient is taken to the operating room. Under mask anaesthesia and complete aseptic conditions, the plastic tube holding the colon is removed. The index finger is passed around the exteriorized colon to break the fibrinous adhesions with the abdominal wall. Following this maneuver, the bowel usually drops easily into the peritoneal cavity. The colostomy defect is closed with 2-3 interrupted No.1 prolene suture. The skin and subcutaneous tissue is left open for delayed primary suture or secondary healing.

## RESULTS

The mean  $\pm$  SD hospital stay for all the patients was 11.5 $\pm$ 2.6 d (8-20 d). Most colonic injuries (81.6%) were grade III (Table 4). Iatrogenic injuries were due to inadvertent tears or devascularization of the colon during re-exploration of the abdomen for other surgical conditions. Comorbid conditions i.e. diabetes mellitus, hypertension, ischaemic heart disease and chronic obstructive airway disease were

**Table 4** Colon injury grades: In 38 patients involved in stab wounds, blast trauma and self-inflicted injuries

Grade	<i>n</i>
II	4 (10.5%)
III	31 (81.6%)
V	3 (7.9%)

**Table 5** Morbidity and mortality

	<i>n</i>
Pulmonary complication	5
Deep vein thrombosis	1
Myocardial infarction & heart failure	3
Incisional hernia	1
Urinary retention	3
Death	1

seen in 40% of cancer patients. Patients presenting with ischaemic colitis following aortic aneurysm repair had concomitant hypertension and ischaemic heart disease, two of them were diabetic and had previous CABG surgery.

14 patients developed various complications (Table 5). Leak from the exteriorized colon anastomosis occurred in two patients. The first was a 64 years frail lady who presented with advanced gastric cancer infiltrating the transverse colon. She developed a leak from the oesophago-jejunostomy and the anastomosis of the exteriorized colon; she developed sepsis and subsequently died of multiple organ failure (MOF) on the 20<sup>th</sup> postoperative day. The second patient was a 53 years old obese female who presented with strangulation of the transverse colon in a big ventral hernia. The gangrenous bowel was resected and anastomosis was exteriorized. On the 5<sup>th</sup> postoperative day, the colon proximal to the exteriorized anastomosis was seen prolapsing out *via* the colostomy wound with oedema and serositis on the surface. It was decided that this colon was not suitable for re-introduction into the peritoneal cavity. Elective laparotomy was performed and a primary side-to-side ileocolic anastomosis to the descending colon was performed using the autosuture G.I. stapler. She was discharged from hospital on the 17<sup>th</sup> postoperative day.

In the other patients interiorization of the bowel was uneventful and all of them passed at least two bowel motion before discharge from the hospital.

## DISCUSSION

Colostomy is practiced since 1793 for emergency management of colon pathologies<sup>[1]</sup>. It became a standard procedure by virtue of its low immediate mortality and ease of performance. Colostomy necessitates staged procedures for closure with repeated hospital admissions and prolonged hospital stay<sup>[6-12]</sup>. The reported complications rate following colostomy creation ranges from 21%-70%<sup>[6-10]</sup>, so much so that some surgeons considered these complications as inevitable<sup>[11]</sup>. The



mortality from these complications is more than 30%<sup>[12,13]</sup>. In a retrospective study of complication following colostomy closure, Parks and Hastings reported an overall 36% complication rate, many of which (27.6%) required more than one operation<sup>[13]</sup>. In a recent paper (2007) the morbidity and mortality of Hartmann's procedure was reported to be 35% and 20% respectively<sup>[14]</sup>. In addition, in the elderly population, colostomy does affect their life style as they often experience difficulty in self-care of the stoma. Many of these patients will never be reconnected and will have the colostomy for life<sup>[11-15]</sup>. Therefore, colostomy and staged procedure for its closure is associated with high mortality and morbidity, and is a financial burden to the health care provider because of repeated admission and prolonged hospital stay.

In 1980, antegrade colonic lavage and primary colonic anastomosis for unprepared bowel was introduced and popularized by Dudley *et al*<sup>[16]</sup>. This technique did reduce hospital stay and morbidity associated with temporary colostomy. It saved patients the staged procedure for reconnecting the colon<sup>[17]</sup>. However, when widely used, on-table colonic lavage was found not to be devoid of problems. It is cumbersome, costly, associated with risk of spillage and contamination and is time consuming<sup>[18-20]</sup>. To satisfactorily irrigate the colon and get a clear effluent about 5 L of irrigation fluid would be required and a 44-50 min of extra-operating time is needed<sup>[19,20]</sup>. This increase in operating time together with the fluid and electrolyte shifts incurred by the massive amount of irrigation fluid adds to the morbidity of the original disease. Significant mortality was reported especially when this procedure was used in the elderly population<sup>[20,22]</sup>. In addition, the reported incidence of anastomotic leaks after on-table irrigation remains at 4%-10%<sup>[17,24,25]</sup>.

Other innovative techniques were introduced for the emergency management of unprepared bowel, namely primary closure and exteriorized anastomosis. These two techniques were first tried in the emergency management of penetrating colon injuries. In 1988, George *et al*<sup>[26]</sup> reported that nearly all penetrating colon injuries can be primarily repaired. In 1995, an editorial by Nance and Nance stated that "a surgeon using colostomy in the management of penetrating colon injury should be required to justify the continuation of this obsolete and discredited practice"<sup>[27]</sup>. Two randomized prospective studies of 109 and 56 patients respectively compared primary repair with diversion colostomy for colonic injuries, reported no difference in complication rate between the two procedures<sup>[28,29]</sup>. More than half of the patients who developed complications in each group required another operation. In addition, moderate to major faecal contamination was reported in 33% and 45% of patients after primary repair and diversion colostomy respectively<sup>[28]</sup>.

The place of primary repair of the colon in the emergency management of other colonic pathologies remains unclear. Primary repair without on-table irrigation was used in 21 patients presenting with acute sigmoid volvulus<sup>[30]</sup>. These authors used caecostomy to protect the colonic anastomosis, a technique not very much favoured by many surgeons. In the emergency management of

malignant colon obstruction, few reports indicated that primary resection and anastomosis without lavage is feasible<sup>[18-21]</sup>. However, these authors did decompress the colon per-operatively via a colonic enterostomy proximal to the obstruction site<sup>[18,31]</sup>. More extensive emergency procedures i.e. subtotal and total colectomy with primary ileo-colic anastomosis were reported by others<sup>[32-34]</sup>. The operative mortality and complications after this procedure were 28% and 39% respectively<sup>[33]</sup>. The few favourable reports after such extensive and time consuming surgery on few selected patients<sup>[32,33]</sup> does not justify its routine application especially in the elderly patients who commonly present with confounding comorbid conditions. Moreover, such major surgery would require the presence of an experienced senior surgeon who is not always available at those odd hours of the night.

In 1945 Major James Mason of the US Army introduced the technique of exteriorization of sutured colon in war injuries<sup>[2]</sup>. In civilian practice colonic and other injuries are associated with less tissue damage than war injuries as they are due to low impact trauma like stabs, blunt trauma and low velocity missiles. It is therefore, expected that the results of exteriorized colonic repair to be better in civilian practice. Few sporadic papers appeared in the civilian literature on the successful outcome after exteriorizing a sutured colon repair<sup>[35,36]</sup>. A literature review on a total of 339 patients in whom the colon was exteriorized after primary repair of penetrating colonic injuries showed that colostomy was avoided in 63.3% of the patients and that this procedure did not expose the patients to any increased morbidity or mortality when compared to diversion colostomy<sup>[3]</sup>. However, this procedures did not gain much momentum by civilian surgeons.

The timing of interiorization or "drop-back" of the exteriorized segment remains uncertain in the literature. It ranged from early at the 5<sup>th</sup> postoperative day<sup>[37]</sup>, to late at 9-14 d<sup>[3,36-38]</sup>. Viable colon exposed to atmospheric air would soon develop serositis which might lead to break down of the suture lines. We, therefore, like Dang *et al*<sup>[37]</sup> advocate early drop-back between the 5<sup>th</sup> and 7<sup>th</sup> d after the primary surgery for several reasons: (a) to avoid the development of serositis, (b) anastomotic leak, would be expected to show itself within this time (c) most patients would have passed at least one bowel motion during this period which would prove the integrity of the anastomosis, (d) the presence of any postoperative intraperitoneal sepsis would be expected to declare itself by this time and (e) the "drop-back" procedure would be easy before the 7<sup>th</sup> postoperative day by just passing a finger around the colon to break the fibrinous adhesion with the abdominal wall before it becomes fibrous requiring sharp dissection. In the group of patients reported in this paper, there was no anastomotic leak after "drop-back" within this period and the bowel was easily interiorized without any sharp dissection. We used the technique of resection, primary anastomosis and exteriorization of unprepared bowel in the emergency management of a variety of colon pathologies, all of which would have otherwise had a routine colostomy.

Traditional surgical training dictates that a "clean"

colon is a pre-requisite for a sound anastomosis. However, recently no association was found between anastomotic leaks and failure to achieve a "clean colon"<sup>[30,39-42]</sup>. In a recent randomized trial, Bucher *et al*<sup>[42]</sup> reported that elective left-sided colorectal surgery without mechanical preparation was safe, it was associated with significantly less complications (8% *vs* 22%) anastomotic leak (1% *vs* 6%) and hospital stay (9.9% *vs* 14.9%) when compared to patients receiving the classical mechanical preparation<sup>[42]</sup>. The previous reports on exteriorized colon repair of unprepared bowel and the results as reported here substantiate this notion. The mainstay to a successful exteriorized colon anastomosis is meticulous attention to details which include: (a) liberal mobilization of the colon to achieve easy exteriorization with no undue tension. Any tension on the suture line is a recipe for failure, (b) completely healthy and bleeding colon edges after resection or debridement, (c) one layer of interrupted seromuscular colon anastomosis, (d) maintain a moist environment by immediate cover of the colon with a colonostomy bag, (e) daily inspection of the colon to check for colour, oedema or leak, and (f) early drop-back into the peritoneal cavity not later than the 7<sup>th</sup> postoperative day. This series demonstrated that, when carefully performed, this technique is associated with minimal morbidity and can save most patients the inconvenience of colostomy.

In many developed countries and the Third World, colostomy appliance are unaffordable or not available, special toilet facilities are non-existing and expert personnel on colostomy care are not available. Procedures which would spare patients the inconvenience of colostomy in these societies would be invaluable. Even in the developed countries where all facilities and expertise are available, a substantial saving in cost would be achieved if patients can avoid colostomy by implementing this technique. The procedure has the advantage of shorter hospital stay, no stoma, one stage surgery and one hospital admission. It does not add any morbidity to the patient and if the suture line breaks, it will function like an ordinary colostomy. Implementing this technique would make colostomy an uncommon emergency procedure not only in the management of colon injuries, but in many other colonic pathologies as shown in the series.

In conclusion, it is always hard to over rule or challenge an orthodox technique or a surgical dictum. Recent literature has challenged the purported advantage of routine colostomy in the emergency management of colon trauma. The cited literature and this paper may justify this challenge and stimulate a wider application of exteriorized colon anastomosis.

## REFERENCES

- Dinnick T. The origins and evolution of colostomy. *Br J Surg* 1934; **22**: 142-145
- Mason JM. Surgery of the colon in the forward battle area. *Surgery* 1945; **18**: 534-541
- Nallathambi MN, Ivatury RR, Rohman M, Stahl WM. Penetrating colon injuries: exteriorized repair vs. loop colostomy. *J Trauma* 1987; **27**: 876-882
- Moore EE, Cogbill TH, Malangoni MA, Jurkovich GJ, Champion HR, Gennarelli TA, McAninch JW, Pachter HL, Shackford SR, Trafton PG. Organ injury scaling, II: Pancreas, duodenum, small bowel, colon, and rectum. *J Trauma* 1990; **30**: 1427-1429
- Abeyatunge LR. A modified technique of colostomy. *Br J Surg* 1972; **59**: 99-100
- Miles RM, Greene RS. Review of colostomy in a community hospital. *Am Surg* 1983; **49**: 182-186
- Bulger EM, McMahon K, Jurkovich GJ. The morbidity of penetrating colon injury. *Injury* 2003; **34**: 41-46
- Leenen LP, Kuypers JH. Some factors influencing the outcome of stoma surgery. *Dis Colon Rectum* 1989; **32**: 500-504
- Pittman DM, Smith LE. Complications of colostomy closure. *Dis Colon Rectum* 1985; **28**: 836-843
- Londono-Schimmer EE, Leong AP, Phillips RK. Life table analysis of stomal complications following colostomy. *Dis Colon Rectum* 1994; **37**: 916-920
- Kodner IJ. Stoma complications. In: Fazio V, ed. Current therapy in colon and rectal surgery, Toronto: BC Decker, 1990: 420-425
- Waldron RP, Donovan IA. Mortality in patients with obstructing colorectal cancer. *Ann R Coll Surg Engl* 1986; **68**: 219-221
- Parks SE, Hastings PR. Complications of colostomy closure. *Am J Surg* 1985; **149**: 672-675
- Constantinides VA, Heriot A, Remzi F, Darzi A, Senapati A, Fazio VW, Tekkis PP. Operative strategies for diverticular peritonitis: a decision analysis between primary resection and anastomosis versus Hartmann's procedures. *Ann Surg* 2007; **245**: 94-103
- Deans GT, Krukowski ZH, Irwin ST. Malignant obstruction of the left colon. *Br J Surg* 1994; **81**: 1270-1276
- Dudley HA, Racliffe AG, McGeehan D. Intraoperative irrigation of the colon to permit primary anastomosis. *Br J Surg* 1980; **67**: 80-81
- Koruth NM, Krukowski ZH, Youngson GG, Hendry WS, Logie JR, Jones PF, Munro A. Intra-operative colonic irrigation in the management of left-sided large bowel emergencies. *Br J Surg* 1985; **72**: 708-711
- Nyam DC, Seow-Choen F, Leong AF, Ho YH. Colonic decompression without on-table irrigation for obstructing left-sided colorectal tumours. *Br J Surg* 1996; **83**: 786-787
- Forloni B, Reduzzi R, Paludetti A, Colpani L, Cavallari G, Frosali D. Intraoperative colonic lavage in emergency surgical treatment of left-sided colonic obstruction. *Dis Colon Rectum* 1998; **41**: 23-27
- Sule AZ, Iya D, Obekpa PO, Ogbonna B, Momoh JT, Ugwu BT. One-stage procedure in the management of acute sigmoid volvulus. *J R Coll Surg Edinb* 1999; **44**: 164-166
- Bak MP, Boley SJ. Sigmoid volvulus in elderly patients. *Am J Surg* 1986; **151**: 71-75
- Taha SE, Suleiman SI. Volvulus of the sigmoid colon in the Gezira. *Br J Surg* 1980; **67**: 433-435
- Lieberman DA, Ghormley J, Flora K. Effect of oral sodium phosphate colon preparation on serum electrolytes in patients with normal serum creatinine. *Gastrointest Endosc* 1996; **43**: 467-469
- Poon RT, Law WL, Chu KW, Wong J. Emergency resection and primary anastomosis for left-sided obstructing colorectal carcinoma in the elderly. *Br J Surg* 1998; **85**: 1539-1542
- Thomson WH, Carter SS. On-table lavage to achieve safe restorative rectal and emergency left colonic resection without covering colostomy. *Br J Surg* 1986; **73**: 61-63
- George SM, Fabian TC, Mangiante EC. Colon trauma: further support for primary repair. *Am J Surg* 1988; **156**: 16-20
- Nance ML, Nance FC. A stake through the heart of colostomy. *J Trauma* 1995; **39**: 811-812
- Gonzalez RP, Merlotti GJ, Holevar MR. Colostomy in penetrating colon injury: is it necessary? *J Trauma* 1996; **41**: 271-275
- Chappuis CW, Frey DJ, Dietzen CD, Panetta TP, Buechter KJ, Cohn I. Management of penetrating colon injuries. A prospective randomized trial. *Ann Surg* 1991; **213**: 492-497; discussion 497-498
- Naaeder SB, Archampong EQ. One-stage resection of acute sigmoid volvulus. *Br J Surg* 1995; **82**: 1635-1636

- 31 **Naraynsingh V**, Rampaul R, Maharaj D, Kuruvilla T, Ramcharan K, Pouchet B. Prospective study of primary anastomosis without colonic lavage for patients with an obstructed left colon. *Br J Surg* 1999; **86**: 1341-1343
- 32 **Feng YS**, Hsu H, Chen SS. One-stage operation for obstructing carcinomas of the left colon and rectum. *Dis Colon Rectum* 1987; **30**: 29-32
- 33 **Fielding LP**, Stewart-Brown S, Blesovsky L. Large-bowel obstruction caused by cancer: a prospective study. *Br Med J* 1979; **2**: 515-517
- 34 **Terry BG**, Beart RW. Emergency abdominal colectomy with primary anastomosis. *Dis Colon Rectum* 1981; **24**: 1-4
- 35 **Okies JE**, Bricker DL, Jordan GL, Beall AC, DeBaake ME. Exteriorized primary repair of colon injuries. *Am J Surg* 1972; **124**: 807-810
- 36 **Kirkpatrick JR**. The exteriorized anastomosis: its role in surgery of the colon. *Surgery* 1977; **82**: 362-365
- 37 **Dang CV**, Peter ET, Parks SN, Ellyson JH. Trauma of the colon: early drop-back of exteriorized repair. *Arch Surg* 1982; **117**: 652-656
- 38 **Lou MA**, Johnson AP, Atik M, Mandal AK, Alexander JL, Schlater TL. Exteriorized repair in the management of colon injuries. *Arch Surg* 1981; **116**: 926-929
- 39 **Santos JC**, Batista J, Sirimarco MT, Guimaraes AS, Levy CE. Prospective randomized trial of mechanical bowel preparation in patients undergoing elective colorectal surgery. *Br J Surg* 1994; **81**: 1673-1676
- 40 **Irving AD**, Scrimgeour D. Mechanical bowel preparation for colonic resection and anastomosis. *Br J Surg* 1987; **74**: 580-581
- 41 **Fielding LP**, Stewart-Brown S, Blesovsky L, Kearney G. Anastomotic integrity after operations for large-bowel cancer: a multicentre study. *Br Med J* 1980; **281**: 411-414
- 42 **Bucher P**, Gervaz P, Soravia C, Mermillod B, Erne M, Morel P. Randomized clinical trial of mechanical bowel preparation versus no preparation before elective left-sided colorectal surgery. *Br J Surg* 2005; **92**: 409-414

S- Editor Liu Y L- Editor Rampone B E- Editor Chen GJ